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| 09/986,919 | 11/13/2001 | Jeawoan Lee | 1567.1021 | 6274 |

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| EXAMINER | |
|---|---|
| RUTHKOSKY, MARK | |
| **ART UNIT** | **PAPER NUMBER** |
| 1745 | |

DATE MAILED: 02/23/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 09/986,919 | LEE ET AL. | |
| | Examiner | Art Unit | |
| | Mark Ruthkosky | 1745 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *25 November 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) 1-12, 44 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-12 and 44* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Response to Amendment*

The application has been amended such that claims 13-43 have been canceled. Claims 3-4 have been amended. Claims 1-12 and 44 are presently pending.

### *Claim Objections*

The objection to claims 3 and 4 under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim has been overcome by applicant's amendment.

### *Claim Rejections - 35 USC § 112*

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 1-12 and 44 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter, which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

In claim 1, the limitation "a current collector having pores comprising at or greater than 60% porosity and less than 90% porosity based on an overall volume of said current collector" is

not in the original disclosure. The numerical ranges in the original disclosure do not show that applicant possessed at the time the invention was made less than 90% porosity. Furthermore, the original disclosure does not include any data to appreciate that less than 90% porosity is significant to applicant's invention. Claims depending from claims rejected under 35 USC 112, first paragraph are also rejected by the same reasoning.

### *Claim Rejections - 35 USC § 103*

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-5, and 9-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chu et al. (US 6,030,720) in view of Peled et al. (US Pat. No. 4,410,609.)

The present claims are drawn to a positive electrode comprising a sulfur based active material where the disclosed inventive concept appears to be a positive electrode porous current collector in which the sulfur based active material is disposed. The product-by-process limitations of claims 5, 9, and 10 are not given patentable weight since the courts have held that patentability is based on a product itself, even if the prior art product is made by a different process (see In re Thorpe, 227 USPQ 964, (CAFC 1985), In re Brown, 173 USPQ 685 (CCPA 1972), and In re Marosi, 218 USPQ 289, 292-293 (CAFC 1983)).

In claim 5, the product by process limitation "wherein said porous current collector comprises a resin foam coated with a metal, where the coated resin foam is subjected to a

pyrolysis process" is not given patentable weight in a product claim. Therefore, a porous metallic current collector would meet the claim limitation.

In claim 9, the product by process limitation "wherein the metal is coated using a coating method that comprises one of electroplating and electroless plating" is not given patentable weight in a product claim.

In claim 10, the product by process limitation "wherein the metal is coated using a coating method that comprises one of electroplating and electroless plating" is not given patentable weight in a product claim.

Chu et al. disclose a lithium sulfur battery comprising a positive electrode comprising a current collector that can be a conductive foam or a thin conductive grid such as a metal-coated polymer fibers or weaves in which the positive electrode material is interspersed throughout the matrix provided by the current collector (col. 9, lines 15-37 and Figures 2A and 2B). Conductive foam or thin conductive grid such as a metal coated polymer fibers or weaves inherently are porous since they provide a matrix in which the positive electrode material is interspersed. The reference also states that the matrix is sufficiently "open" that there is room for precipitated electroactive material to deposit on the matrix (col. 10, lines 39-56). The positive electrode material is interspersed through the matrix provided by the current collector (col. 9, lines 27-30). Current collector materials may be made of a material such as aluminum that is resist to degradation in the electrochemical environment of the cell (col. 8, lines 13-34).

The positive electrode material may be elemental sulfur, sulfides, polysulfides, redox sulfur polymers (col. 6, lines 5-42 and col. 19, lines 6-15), and $Li_2S_x$ where x is a value of 1 or greater (col. 9, lines 40-55). The positive electrode material may be interspersed into the current

collector material by providing a slurry containing the sulfur based active material, a suitable binder, electroconductive agent, and solvent (col. 17, lines 24-40) and coating the slurry onto a porous current collector such as carbon fiber paper (col. 17, lines 30-35) where the carbon fiber paper is impregnated with the slurry and the solvent is evaporated (col. 23, lines 23-50 and col. 19, lines 45-58).

The negative electrode material may be lithium metal, lithium alloy, carbon based-lithium ion that reversibly intercalates and deintercalates lithium ions (col. 21, lines 1-46). A separator separates the positive electrode and the negative electrode and may be glass, plastic, ceramic, or a polymeric entraining liquid electrolyte (col. 8, lines 43-61). The battery contains a liquid electrolyte containing a lithium salt which impregnates (permeates) the negative electrode, positive, electrode, and separator (col. 14, lines 43-67 and col. 16, lines 1-6) and where the electrolyte also transfers lithium metal ions (col. 10, lines 1-6). Chu et al. ('720) do not disclose that the current collector comprises at least 60% porosity and less than 90% porosity based on an overall volume of the current collector.

Peled et al. teach a lithium-sulfur battery comprising a porous positive electrode current where the porosity of the positive electrode current collector is advantageously about 80% or 75-90% (col. 4, lines 1-23). The current collector is charged with sulfur. It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the porosity of the current collector of Chu et al. ('720) to be 80% porous because such porosity would allow for high sulfur loading in the electrode, as noted in the reference, and would provide a cathode with high porosity so as to provide extensive electrolyte solvent communication throughout the

bulk of the cathode, which gives improved ionic conductivity in the electrode and improved electrical conductivity with the current collector, which leads to improved battery performance.

Claims 1-5, and 9-12 rejected under 35 U.S.C. 103(a) as being unpatentable over Chu (US Patent No. 5,686,201) in view of Peled et al. (US Pat. No. 4,410,609).

The product-by-process limitations of claims 5, 9, and 10 are not given patentable weight as previously noted since the courts have held that patentability is based on a product itself, even if the prior art product is made by a different process (see In re Thorpe, 227 USPQ 964, (CAFC 1985), In re Brown, 173 USPQ 685 (CCPA 1972), and In re Marosi, 218 USPQ 289, 292-293 (CAFC 1983)).

Chu discloses a positive electrode containing active-sulfur based composite electrodes in a lithium sulfur battery (col. 1, lines 15-27 and col. 4, lines 29-60). The positive electrode comprises active sulfur (in the form of elemental sulfur in the examples provided in the reference), binder and a conductive agent such as carbon black (col. 5, lines 9-43). The current collector to which the positive electrode slurry is applied can be I the form of expanded metals, screens, meshes, and foams as is known in the art (col. 15, lines 3-20). The current collector can be made of aluminum, copper, titanium or other conductive material that would not react at operating cell conditions. Chu et al. ('201) do not disclose that the current collector comprises at least 60% porosity and less than 90% porosity based on an overall volume of the current collector.

Peled et al. teach a lithium-sulfur battery comprising a positive electrode current collector that is porous and the porosity of the positive electrode current collector is advantageously about

80% or 75-90% (col. 4, lines 1-23). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the porosity of the current collector of Chu et al. ('201) to be 80% porous because such porosity would allow for high sulfur loading in the electrode, as noted in the reference, and would provide a cathode with high porosity so as to provide extensive electrolyte solvent communication throughout the bulk of the cathode, which gives improved ionic conductivity in the electrode and improved electrical conductivity with the current collector, which leads to improved battery performance.

Claims 6-8, and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chu (US Patent No. 5,686,201) in view of Peled et al. (US Pat. No. 4,410,609) as applied to claims 1 and 5 above, and further in view of Kawakami (US Patent No. 6,475,664).

Chu et al. ('201) as modified by Peled et al. disclose all the limitations of claims 6-8, and 44 except that the metal foam comprises a carbon conductive agent other than the metal, that the porous current collector comprises the non-woven fabric coated with a metal, or that the porous current collector comprises a carbon fiber.

Kawakami disclose that current collectors in the form of a metal foam for a positive electrode of a battery can be obtained by 1) coating the surface of a sheet-shaped organic polymer resin having a three dimensional network structure of urethane foam with a metal film of nickel or the like by means of plating or the like and subjecting the resultant to sintering to decompose and remove the polymer resin, or 2) obtained by coating the surface of a carbon fiber felt (which is a nonwoven fabric) with a metal film of nickel or the like by means of plating or the like and such current collectors efficiently supply an electric current consumed in

or collect an electric current generated in the electrode reaction upon charging or recharging and are highly electrically conductive and inactive in a battery reaction (col. 13, lines 62-67 and col. 14, lines 1-14). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use a metal foam as a current collector in the battery of Chu ('201) obtained by 1) coating the surface of a sheet-shaped organic polymer resin having a three dimensional network structure of urethane foam with a metal film of nickel or the like by means of plating or the like and subjecting the resultant to sintering to decompose and remove the polymer resin, or 2) obtained by coating the surface of a carbon fiber felt (which is a nonwoven fabric) with a metal film of nickel or the like by means of plating or the like because such metal foam current collectors efficiently supply an electric current consumed in or collect an electric current generated in the electrode reaction upon charging or recharging and are highly electrically conductive and inactive in a battery reaction.

Claims 6-8, and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chu et al. (US 6,030,720) in view of Peled et al. (US Pat. No. 4,410,609) as applied to claims 1 and 5 above, and further in view of Kawakami (US Patent No. 6,475,664).

Chu et al. ('720) as modified by Peled et al. disclose all the limitations of claims 6-8, and 44 except that the metal foam comprises a carbon conductive agent other than the metal, that the porous current collector comprises the non-woven fabric coated with a metal, or that the porous current collector comprises a carbon fiber.

Kawakami disclose that current collectors in the form of a metal foam for a positive electrode of a battery can be obtained by 1) coating the surface of a sheet-shaped organic polymer resin having a three dimensional network structure of urethane foam with a metal film of nickel or the like by means of plating or the like and subjecting the resultant to sintering to decompose and remove the polymer resin, or 2) obtained by coating the surface of a carbon fiber felt (which is a nonwoven fabric) with a metal film of nickel or the like by means of plating or the like and such current collectors efficiently supply an electric current consumed in or collect an electric current generated in the electrode reaction upon charging or recharging and are highly electrically conductive and inactive in a battery reaction (col. 13, lines 62-67 and col. 14, lines 1-14). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use a metal foam as a current collector in the battery of Chu ('720) obtained by 1) coating the surface of a sheet-shaped organic polymer resin having a three dimensional network structure of urethane foam with a metal film of nickel or the like by means of plating or the like and subjecting the resultant to sintering to decompose and remove the polymer resin, or 2) obtained by coating the surface of a carbon fiber felt (which is a nonwoven fabric) with a metal film of nickel or the like by means of plating or the like because such metal foam current collectors efficiently supply an electric current consumed in or collect an electric current generated in the electrode reaction upon charging or recharging and are highly electrically conductive and inactive in a battery reaction.

***Response to Arguments***

Applicant's arguments filed 11/25/2005 have been fully considered but they are not persuasive.

*With respect to claims rejected under 35 USC 112, first paragraph, the applicant contends the range of at or greater than 60% and less than 90% is supported in claims 3-4 of the original disclosure.*

In response, the Examiner notes that this language is not found in original claims 3-4. Specifically, there is no support for "less than 90% porosity." Original claim 4 reads, "The positive electrode of claim 1, wherein the pores of said current collector comprise *at least 80 to 90% porosity* of an overall volume of said current collector." The term "at least" sets a lower limit on the porosity, but not an upper limit on the porosity. Due to the importance of each word in original claim 4 with regard to the disclosure, applicant is encouraged to use the language supported in the original claim to describe the porosity claimed invention. Based on claims 3-4, as argued, the applicant has not provided support for the amended claim language, "less than 90% porosity." The numerical ranges in the original disclosure do not show that applicant possessed at the time the invention was made a range less than 90% porosity, but greater than or equal to 60%. The original disclosure does not include any data to appreciate that less than 90% porosity is significant to applicant's invention.

*With respect to art rejections based on Chu as modified by Peled, applicant asserts that there is motivation found in the references to combine Chu with Peled.*

Applicant relies on section 2143.01 of the MPEP, which states that "obviousness can only be established by combining or modifying the teachings of the prior art to produce the

claimed invention where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves." Clearly, Peled provides the teaching to modify the prior art reference of Chu to produce the claimed invention as the porosity of the current collector is taught to be advantageously about 80% or 75-90% porous, as found explicitly in the reference. MPEP 2144 states that the rationale to modify or combine the prior art does not have to be expressly or impliedly contained in the prior art. It may be reasoned from knowledge generally available to one of ordinary skill in the art, established scientific principles, or legal precedent established by prior case law.

The motivation to combine Peled with Chu as stated above is that the high porosity current collector of Peled allows extensive electrolyte solvent communication throughout the bulk of the cathode. This will provide the bulk of the electrode with higher amounts of electrolyte, which transfers ions in the cell. Further, the reduction of the active material that inherently occurs at the cathode gives an electron to the battery circuit through the current collector. Having the active material in the pores of the current collector allows for the electrons of the bulk to be conducted through the current collector. As noted in the previous office action, it is also well known in the art that increased loading of the cathode active material would be achieved when the current collector is highly porous which would also increase cathode real surface area, which in turn would greatly improve cell current density, as evidenced by Chottiner (US Patent No. 4,152,489, a 75% to 95% porous metal current collector is taught to have between 45% to about 90% of its pore volume be filled with active material (abstract) with increased battery power output.)

***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

***Examiner Correspondence***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mark Ruthkosky whose telephone number is 571-272-1291. The examiner can normally be reached on FLEX schedule (generally, Monday-Thursday from 9:00-6:30.) If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached at 571-272-1292. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications

may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Mark Ruthkosky
Primary Patent Examiner
Art Unit 1745

2/16/06